EXPEDITED PROCEDURE – EXAMINING GROUP 2813

S/N 09/961036 **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Madhav Datta et al.	Examiner: Erik Kielin
Serial No.:	09/961036	Group Art Unit: 2813
Filed:	September 21, 2001	Docket No.: 884.523US1
Title:	DUAL-STACK, BALL-LIMITING METALLURGY AND METHOD OF MAKING SAME	
Assignee:	Intel Corporation	Customer No.: 21186

PETITION UNDER 37 C.F.R. 1.181

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In response to the Final Office Action mailed September 13, 2004, please consider the petition as follows:

IN THE CLAIMS

The claims have not been amended herein, but are provided for the convenience of the Petitions Branch.

1-16. (Canceled)

17. (Previously Presented) A process comprising:

forming a metallization;

forming a refractory metal first layer over the metallization;

forming a refractory metal second layer over the refractory metal first layer;

forming a refractory metal third layer above and on the refractory metal second layer, wherein the refractory metal third layer is substantially the same metal as the refractory metal first layer;

forming a refractory metal fourth layer above and on the refractory metal third layer, wherein the refractory metal fourth layer is substantially the same metal as the refractory metal second layer; and

forming an electrically connective bump above the refractory metal fourth layer.

18. (Original) The process according to claim 17, wherein forming a metallization comprises:

forming a copper metallization pad over a substrate, wherein the copper metallization pad makes contact with a metallization selected from a range of metal-one (M1) to M6.

19. (Original) The process according to claim 17, wherein forming a refractory metal first layer over the metallization comprises:

depositing the refractory metal first layer by physical vapor deposition of a composition selected from Ni, Co, Pd, Pt, Ti, Zr, Hf, Cr, Mo, W, Sc, Y, La, and Ce.

20. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization comprises:

sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å.

21. (Original) The process according to claim 17, wherein forming a refractory metal second layer over the refractory metal first layer comprises:

depositing the refractory metal second layer by physical vapor deposition of a composition selected from Ni, Co, Pd, Pt, NiV, CoV, PdV, PtV, Ti, Zr, Hf, Cr, Mo, W, Sc, Y, La, and Ce in a solid-solution or stoichiometric ratio.

22. (Withdrawn) The process according to claim 17, wherein forming a refractory metal second layer over the refractory metal first layer comprises:

sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

23. (Original) The process according to claim 17, wherein forming a refractory metal third layer over the metallization comprises: depositing the refractory metal third layer by physical vapor deposition.

24. (Withdrawn) The process according to claim 17, wherein forming a refractory metal third layer over the metallization comprises:

sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å.

25. (Original) The process according to claim 17, wherein forming a refractory metal fourth layer over the refractory metal first layer comprises:

depositing the refractory metal fourth layer by physical vapor deposition.

26. (Withdrawn) The process according to claim 17, wherein forming a refractory metal fourth layer over the refractory metal first layer comprises:

sputtering NiV over the refractory metal third layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

27. (Withdrawn) A process comprising:

forming a metallization;

sputtering a refractory metal first layer over the metallization;

sputtering a refractory metal second layer over the refractory metal first layer, wherein the refractory metal second layer is a refractory metal alloy;

sputtering a refractory metal third layer above and on the refractory metal second layer, wherein the third refractory metal is substantially the same metal as the refractory metal first layer;

sputtering a refractory metal fourth layer above and on the refractory metal third layer, wherein the refractory metal fourth layer is substantially the same metal as the refractory metal first layer; and

plating a Sn-containing solder through a mask onto the refractory metal fourth layer to form an electrically connective bump.

28. (Withdrawn) The process according to claim 27, further comprising:

etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder; and

reflowing the solder.

29. (Withdrawn) The process according to claim 27, further comprising

first anisotropic etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder;

second isotropic etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder and to the mask; and

reflowing the solder.

30. (Withdrawn) The process according to claim 27, further comprising:

anisotropically etching the mask and the first-through-fourth refractory metal layers by using the bump precursor as a shadow mask; and

etching the first-through-fourth refractory metal layers with an etch recipe that is selective to the solder.

31. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, and wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

32. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å, and wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å.

33. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å, wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å, and wherein forming a refractory metal fourth layer over the refractory metal first layer includes sputtering NiV over the refractory metal third layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

34. (Withdrawn) The process according to claim 17, wherein forming a metallization includes:

forming a copper metallization pad over a substrate, wherein the copper metallization pad makes contact with a metallization selected from a range of metal-one (M1) to M6; and

wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 Å to about 2,000 Å, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 Å to about 4,000 Å, wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 Å to about 2,000 Å, and wherein forming a refractory metal fourth layer over the refractory metal first layer includes sputtering NiV over the refractory metal third layer to a thickness in a range from about 1,000 Å to about 4,000 Å.

35. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization comprises:

sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units.

36. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units, and wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 of the arbirtary units to about 4,000 of the arbirtary units.

37. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 of the arbirtary units to about 4,000 of the arbirtary units, and wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 of the arbirtary units to about 2,000 of the arbirtary units.

38. (Withdrawn) The process according to claim 17, wherein forming a refractory metal first layer over the metallization includes sputtering Ti over the metallization to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units, wherein forming a refractory metal second layer over the refractory metal first layer includes sputtering NiV over the refractory metal first layer to a thickness in a range from about 1,000 of the arbirtary units to about 4,000 of the arbirtary units, wherein forming a refractory metal third layer over the metallization includes sputtering NiV over the refractory metal second layer to a thickness in a range from about 500 of the arbirtary units to about 2,000 of the arbirtary units, and wherein forming a refractory metal fourth layer over the refractory metal first layer includes sputtering NiV over the refractory

metal third layer to a thickness in a range from about 1,000 of the arbitrary units to about 4,000 of the arbitrary units.

39. (Withdrawn) The process according to claim 17, further including:

nitriding at least one of the metal second layer and the metal fourth layer to form a nitrided metal alloy or a nitrided vanadium-doped metal.

40. (Withdrawn) The process according to claim 17, wherein the refractory metal first layer, the refractory metal second layer, the refractory metal third layer, and the refractory metal fourth layer include a four-metal-layer stack, the process further including:

plating a bump precursor over the four-metal-layer stack.

41. (Withdrawn) The process according to claim 17, wherein the refractory metal first layer, the refractory metal second layer, the refractory metal third layer, and the refractory metal fourth layer include a four-metal-layer stack, the process further including:

electroless plating a bump precursor over the four-metal-layer stack.

42. (Withdrawn) The process according to claim 17, wherein the refractory metal first layer, the refractory metal second layer, the refractory metal third layer, and the refractory metal fourth layer include a four-metal-layer stack, the process further including:

plating a bump precursor over the four-metal-layer stack; and

further processing the four-metal-layer stack to remove the four-metal-layer stack except under the bump precursor.

43. (Withdrawn) A process comprising:

forming a metallization;

forming a Ti first layer over the metallization to a thickness in a range

from about 500 arbitrary units to about 2,000 arbitrary units;

forming a NiV second layer over the Ti first layer to a thickness in a range from about 1,000 of the arbirtary units to about 4,000 of the arbirtary units;

forming a Ti third layer over the NiV second layer to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units; and

forming a NiV fourth layer over the Ti third layer to a thickness in a range from about 500 arbitrary units to about 2,000 arbitrary units.

44. (Withdrawn) The process according to claim 43, wherein the Ti first layer, the NiV second layer, the Ti third layer, and the NiV fourth layer include a four-metal-layer stack, the process further including:

plating a bump precursor over the four-metal-layer stack; and

further processing the four-metal-layer stack to remove the four-metal-layer stack except under the bump precursor.

45. (Withdrawn) The process according to claim 43, further including:

plating a Sn-containing solder through a mask onto the NiV fourth layer to form an electrically connective bump;

etching the first-through-fourth layers with an etch recipe that is selective to the solder; and

reflowing the solder.

REMARKS

This responds to the Office Action mailed on September 13, 2004.

Claims 17-45 are now pending in this application, although claims 20, 22, 24, and 26-45 are withdrawn from consideration.

Objection to the Drawings under 37 CER. §1.83(a)

The drawings were objected to under37 C.F.R. §1.83(a). Applicant submits this Petition to the Petitions Branch, to reconsider the objection by the Examiner. Claim 18 reads:

18. (Original) The process according to claim 17, wherein forming a metallization comprises:

> forming a copper metallization pad over a substrate, wherein the copper metallization pad makes contact with a metallization selected from a range of metal-one (Ml) to M6.

The text that supports claim 18 is taken from the Detailed Description and Figure 1:

> **Figure 1** is a cross-section of a semiconductor structure 10 during fabrication that includes a substrate 12 and a metallization 14 such as a copper pad that makes connection to what is commonly referred to as metal six (M6) *by way of non-limiting example.* Metallization 14 may be disposed upon an upper surface 16 of substrate 12 where substrate 12 may be an interlayer dielectric (ILD) composition. A nitride layer 18 is formed over substrate 12, and a passivation layer 20 is formed over nitride layer 18, substrate 12, and metallization 14. Passivation layer 20 and nitride layer 18 act to protect substrate 12 and to expose metallization 14 according to the patterning.

(Emphases added).

Where the Examiner may query to understand the meaning of a claim, and where the Applicant can give a reasonable explanation to resolve the query, the Examiner should not ascribe a unique meaning to the disclosure that obscures the plain meaning of

the claim. Neither should the Examiner hold the Applicant to every possible meaning, particularly where unreasonable and improbable, when a reasonable meaning is discernible from the disclosure.

The Examiner assumes that the scope of claim 18 always requires six metallization layers present. e.g. "the *uppermost* metal layer M6" (Office Action at page 5, emphasis in original). This assumption is in error and should be withdrawn.

The Examiner developed of a unique, imaginative, and obscure meaning for claim 18 that is not disclosed or intended. This unique meaning has grown to "it is not conventional to somehow form a contact pad *below* other metal layers." (Ibid., emphasis in original). Under this unique meaning developed by the Examiner, the objection might be meritorious. Applicant considers the plain meaning, as supported by the figures and claim 18, not to be part of this unique meaning that has been developed by the Examiner.

Claim 18 describes no such unique meaning, nor does the balance of Applicant's disclosure. Claim 18 enumerates a range from "wherein the copper metallization pad makes contact with a metallization selected from a range of metal-one (Ml) to M6", i.e., Ml, M2, M3, M4, M5, and M6. The disclosure does not assert, as the Examiner suggests, that the copper metallization pad could be in contact with a lower metallization. If the upper metallization were to be an Ml, claim 18 covers this limitation. If the upper metallization were to be an M2, claim 18 covers this limitation, etc. That Applicant did not illustrate any metallization because they are conventional, and therefore supports the plain meaning of claim 18.

Applicant respectfully petitions that the Examiner's objections to be overturned.

Conclusion

Applicant respectfully submits that this petition, when granted, will facilitate further prosecution of the instant application. The Office is invited to telephone Applicant's attorney, John Greaves, at 810-278-9171, or Applicant's below-named representative, at 612-349-9592 to facilitate prosecution of this application.

Please charge Deposit Account No. 19-0743 in the amount of $400 pursuant to 37 C.F.R. 1.17(f). If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

MADHAV DATTA ET AL.

By their Representatives,

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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Mail Stop AF, Commissioner of Patents, P.O.Box 1450, Alexandria, VA 22313-1450, on this 13th day of December, 2004.

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